Apollo®
Mode A/C Transponder
Model SL70
Installation Manual

September 2003

560-0402-01a

Garmin AT, Inc.
P.O. Box 13549
Salem, OR 97309

2345 Turner Rd. SE
Salem, OR 97302
U.S.A.

Phone 503.581.8101
800.525.6726
In Canada 800.654.3415
Fax 503.364.2138

HISTORY OF REVISIONS

Revision	Date	Description
--	8/26/99	Initial release.
-00a	9/23/99	Added new connector pins and crimping tools
-01	4/3/03	Updated to reflect new software/hardware features including remote operation, new serial I/O messages, addition transmit serial port and altitude hold annunciator output. Added TSO requirements to Environmental Qualification Form.
-01a	9/10/03	Changed UPSAT logo and references to Garmin logo. Also added JTSO information.

IMPORTANT NOTE

The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install this article on or within a specific type or class of aircraft to determine that the aircraft operating conditions are within TSO standards. The article may be installed only if further evaluation by the applicant documents an acceptable installation and is approved by the Administrator.

ORDERING INFORMATION

To receive additional copies of this publication, order part # **560-0402-xx,** *Apollo SL70 Mode A/C Transponder Installation Manual*.

REFERENCE PUBLICATIONS

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SECTION 1 - INTRODUCTION

ABOUT THIS MANUAL

This manual describes the installation of the Apollo SL70 transponder . It is intended for use by persons certified by the Federal Aviation Administration (FAA) to install aircraft avionics.

Section 1 — Provides an **introduction** to the Apollo SL70 unit. TSO certification information is also included in this section.

Section 2 — Includes **installation** and checkout procedures.

Section 3 — Includes complete **specifications**.

Section 4 — Includes **limitations** for the equipment and installation.

Appendix A — Includes **troubleshooting** information.

Appendix B — Includes **periodic maintenance** requirements.

Appendix C — Includes the **environmental qualification form**.

Appendix E — Includes **serial data protocol** specifications.

APOLLO SL70 DESCRIPTION

The Apollo SL70 is a TSO-C74c, Class A2/JTSO-C74c, Class 2A mode A/C transponder. The SL70, in addition to providing replies to ATC interrogations, includes an altitude display and altitude hold function and user-friendly interface features including rotary knob squawk code selection, a VFR button, and built-in self-test and diagnostics.

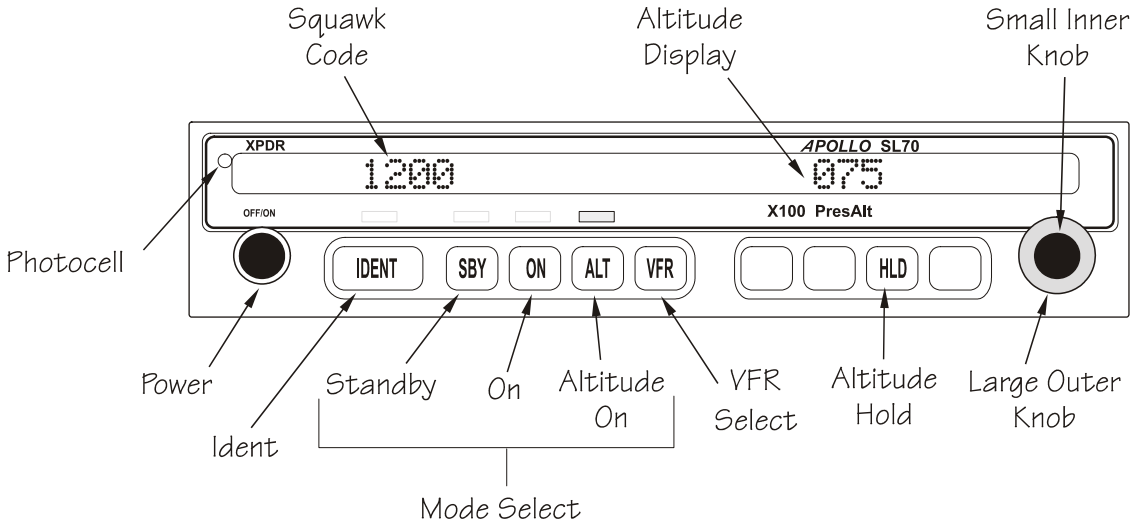


Figure 1 SL70 Front Panel

FEATURES

- small size 1.3" panel height
- full range input supply voltage
- high brightness LED display
- altitude display
- altitude hold function
- gray code or RS-232 serial data altitude input
- RS-232 altitude data output
- built-in self-test and diagnostics

REGULATORY COMPLIANCE

The Apollo SL70 is designed and tested to meet the following TSO/JTSO:

- FAA TSO-C74c, Class A2/JTSO-C74c, Class 2A

The SL70 complies with the FCC requirements specified in:

- CFR 47, Part 87, Aviation Services, Subpart D, Technical Requirements

The SL70 software is designed and tested to RTCA/DO-178B, level C/ED-12B, level C.

Note: Un-authorized changes or modifications to the SL70 may void the compliance to regulatory agency requirements and authorization for continued equipment usage.

UNPACKING THE EQUIPMENT

Carefully unpack the equipment. Visually inspect the package contents for any evidence of shipping damage. Retain all shipping containers and packaging material in case reshipment is necessary.

PACKAGE CONTENTS

As shipped from the Garmin AT factory, the Apollo SL70 package includes most necessary items for installation other than supplies normally available at the installation shop, such as wire and coax cable, the antenna, or any optional switches. The items included in the package are listed in Table 1.

Table 1 Package Contents

Part #	Description	Qty
Apollo SL70 Transponder, Part 3 430-6090-1xx		
Apollo SL70 Installation Kit, Part # 424-0306-xx		
162-0103 or 162-1577	37 pin D-sub connector shell	1
162-0043	Right angle coax plug	1
202-0001	Cable tie	2
204-0037	Edge grommet	6”
221-0400	4-40 x ¼ SS pan head Phillips machine screw with lock washer	10
224-0404	4-40 x ¼ flat head Phillips machine screw	2
240-0008	9/16 OD flat washer	1
245-0022 or 245-0027	Crimp contact for dsub, 20 to 24 awg wire	37
265-0007	7/16” retaining ring	1
310-2295-00	Connector mounting bracket	1
310-5181-00	Mounting frame	1
998-0048	3/32 hex driver	1
Apollo SL70 Manual Kit, Part # 564-0072-xx		
560-0401-00	SL70 User’s Manual	1
560-0402-00	SL70 Installation Manual	1

OTHER REQUIRED MATERIALS

In addition to the materials supplied with the SL70, the following is required.

- a suitable 2A circuit breaker
- an altitude data source – either gray code or RS232

- a standard transponder antenna (see Antenna information on pages 6 and 19)

SPECIAL TOOLS REQUIRED

Crimp Tool

A crimp tool meeting MIL specification M22520/1-01 and a positioner/locater are required to ensure consistent, reliable crimp contact connections for the rear 15 pin connector. These tools are available from:

For pin p/n 162-0100

Astro Tool Corp. 21615 SW TV Highway Beaverton, OR 97006	Phone (503) 642-9853 Fax (503) 591-7766
Crimp tool: Positioner:	Astro Tool part #615708 Astro Tool part #616356

For pin p/n 162-1575

ITT Cannon 1851 E. Deere Ave. Santa Ana, CA 92705-6500	Phone (714) 261-5300 Fax (714) 575-8324
Insertion tool: Regular duty Crimp tool: Regular duty Locator tool: Heavy duty Crimp tool: Heavy duty Locator tool:	ITT part # 274-7006-000 (Desc. CIET-20HD) ITT part #995-0001-585 (Desc. M22520/1-01) ITT part #995-0001-244 (Desc. TH25) ITT part #995-0001-584 (Desc. M22520/2-01) ITT part #995-0001-604 (Desc. M22520/2-08)

SECTION 2 - INSTALLATION

This section describes the installation of the Apollo SL70 including mounting, wiring, and connections. A post installation check-out procedure is included at the end of this section.

PRE-INSTALLATION INFORMATION

Always follow good avionics installation practices per FAA Advisory Circulars AC 43.13-1B, 43.13-2A, or current FAA guidance.

Follow the installation procedure in this section as it is presented for a successful installation. Read the entire section before beginning the procedure. Perform the post installation check-out before closing the work area in case problems occur.

INSTALLATION OVERVIEW

A successful installation should start with careful planning including determination of mounting location for the SL70, antenna location and mounting, connections to an altitude data source, power, cable routing, and other required modifications.

Once the mounting location has been determined, prepare the mounting frame for installation. It may be easier to complete the wiring harness and attach the connectors to the mounting frame prior to installing the mounting frame in the aircraft.

INSTALLATION CONSIDERATIONS

MOUNTING CONSIDERATIONS

The SL70 is designed to mount in the avionics stack in the aircraft instrument panel within easy view and reach of the pilot. The standard package includes the mounting frame for ease of mounting, connections, and service of the unit. Allow an additional one inch clearance to the rear of the mounting frame for connections and cables.

For typical installations, the SL70 does not require external cooling. When mounting the unit, leave a clearance of 1/8 to 1/4 inch between avionics to allow for air circulation.

MINIMUM SYSTEM CONFIGURATION

The SL70 requires connections to the following equipment as a minimum:

- power input
- altitude data – gray code or RS232
- a standard transponder antenna

ALTITUDE INPUT

The SL70 can use either a standard altitude gray code input from an encoding altimeter or an RS-232 input from a serial encoder. For new installations, a serial encoder is recommended because it simplifies the wiring and is more reliable. The SL70 can detect failures on the RS-232 input, thereby eliminating erroneous mode C altitude replies.

The altitude source must be accurate to within ±125 feet, 95% probability, and have a resolution of 100 feet (the serial input resolution may be better than 100feet).

ANTENNA

The antenna shall be a standard transponder quarter wave monopole antenna, such as the TED #104-12 or Comant CI-101.

EQUIPMENT MOUNTING

Once the cable assemblies have been made, attach the 37 pin dsub and coaxial cable connectors to the rear connector mounting plate and the mounting frame as illustrated in Figure 2 and Figure 3. Route the wiring bundle as appropriate. The rear connector plate should be attached to the mounting frame before installing the frame in the instrument panel. The rear connector plate can be used to tie down the cable assemblies. Connect the shields on any shielded cables directly to the connector mounting plate.

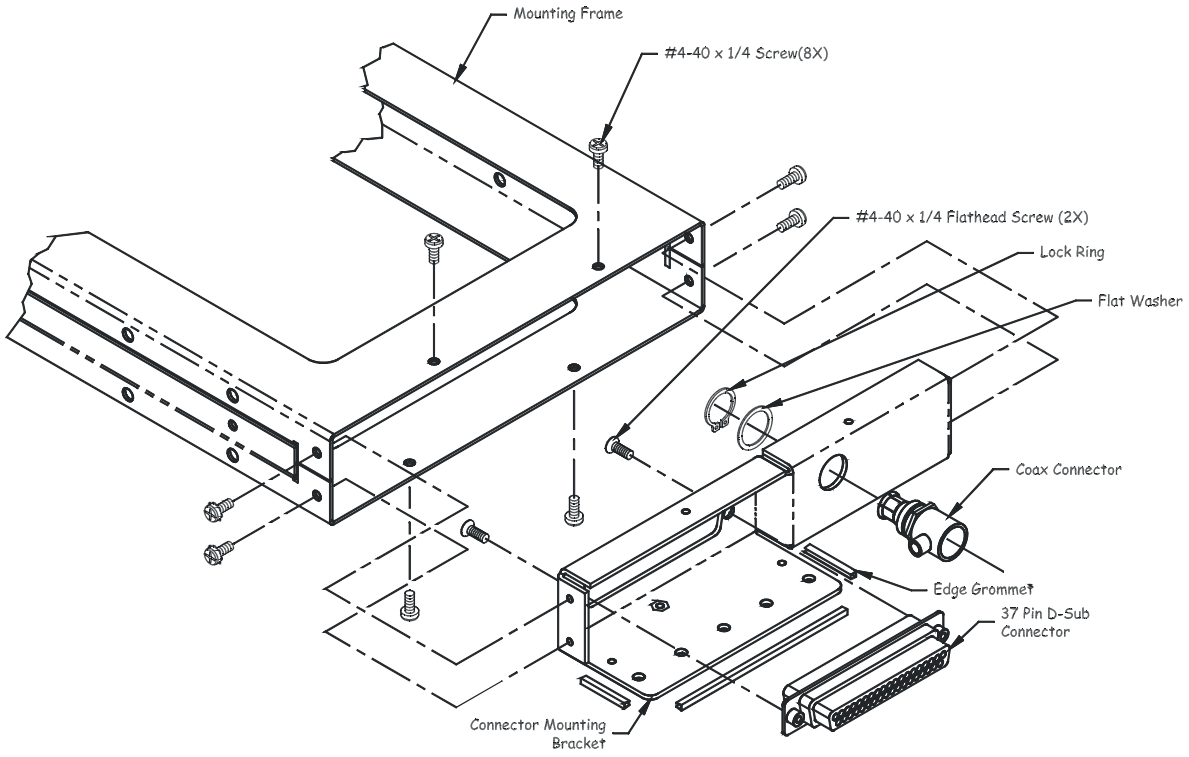


Figure 2 Mounting Frame Assembly

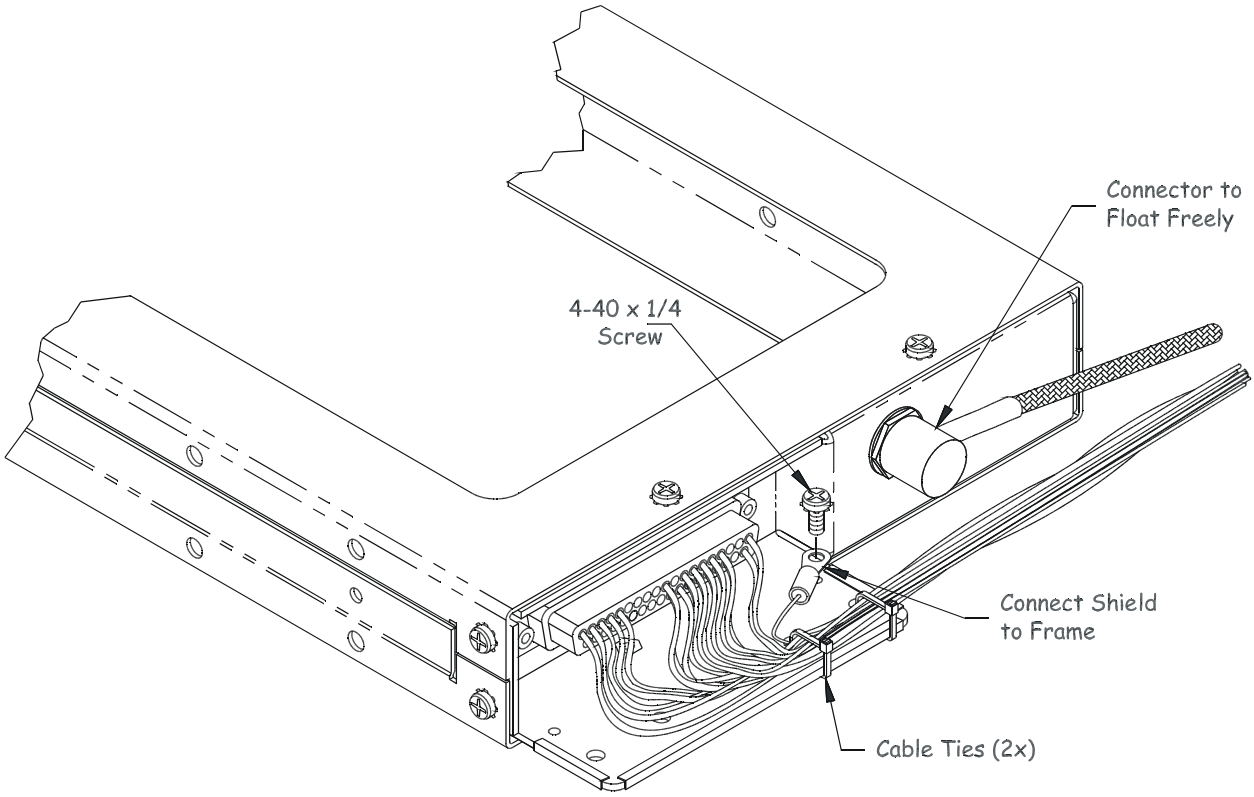


Figure 3 Cable Routing

Once the cable assemblies are complete and the connectors are attached to the mounting frame, install the mounting frame assembly in the aircraft instrument panel. Be sure to use low profile head screws so the unit will slide in and out freely. Attach the front of the mounting frame to the instrument panel. Use support brackets to attach the rear of the frame to the aircraft.

UNIT INSTALLATION / REMOVAL

To install the SL70 in the mounting frame, make sure the cam lock is rotated so the rear part is up, then slide the unit into the frame and tighten with the 3/32 hex tool. The unit will be pulled into the frame by the cam lock and the connectors will fully engage.

To remove the SL70 from the mounting frame, use the hex tool and turn the tool CCW. The unit will be pushed out of the frame by the cam lock assembly. No special extraction tools are required.

ELECTRICAL CONNECTIONS

The SL70 installation kit includes a 37 pin dsub shell and crimp contacts. The crimp contacts are specified for 20 to 24 AWG wire. Make the crimp connections with a crimp tool as specified in the Special Tools Required section on page 4. All wires should be 20 to 24 AWG unless otherwise specified. Wiring diagrams are included on pages 10 and 11.

POWER

The SL70 is internally fused at 3 amps. A separate 2 amp circuit breaker or fuse should be installed for downline overload or short circuit protection. Make the power connections to the SL70 using 20 AWG wire.

Note: *Circuits should be protected in accordance with guidelines in AC 43.13-1B, chapter 11, section 4.*

ALTITUDE INPUT

The SL70 can use altitude data from either a standard gray code altitude or from an RS-232 serial altitude source.

If using the gray code altitude input, connections can be made directly from the SL70 to the altitude source. Isolation diodes are included within the SL70. Make sure a common ground connection exists, or connect a ground wire between the source and the SL70.

If using the RS-232 serial altitude input, make the connections as described in the following section.

SERIAL INTERFACE

The SL70 includes an RS-232 serial port which can be used for inputting or outputting altitude data. This is an optional connection if the altitude gray code input is used.

When making serial connections to the SL70, use a shielded two or three conductor cable. Make the RxD, TxD, and serial ground connections on the 37 pin dsub connector. Connect the shield to the rear of the mounting frame on the connector plate.

Complete serial interface specifications are included in Appendix E.

DISCRETE INPUTS

Remote Ident

The ident input can be connected to a remotely mounted momentary switch to initiate the ident function the same as using the front panel IDENT button.

When using the ident input, connect it to a remotely mounted momentary switch, and connect the other terminal of the switch to ground.

Remote Standby

The standby input is for use when the installation includes more than one transponder. When two transponders are installed, connect the standby input to a two position selector switch, with the common on the switch connected to ground. The SL70 will be in standby when the input is pulled low to ground.

Suppresion Input

The suppress input is used when installed with a DME that includes a suppression output. The transponder will be suppressed, or will not generate replies, when the input is driven high from the DME (or other source). To use the suppression input, connect it to the suppression output on a DME (or other appropriate suppression source).

ANTENNA INSTALLATION AND CONNECTIONS

The antenna should be mounted in a vertical position in an area on the bottom of the aircraft away from other antennas or landing gear.

The antenna coax cable should be a double shielded low loss cable and must have a cable loss of < 3 dB at 1090MHz, including connectors. A typical installation should have a cable loss of 1½ to 2 dB. Several suitable coaxes are RG142B and RG400.

The assembly of the rear panel coax connector included with the installation kit is illustrated in the following figure.

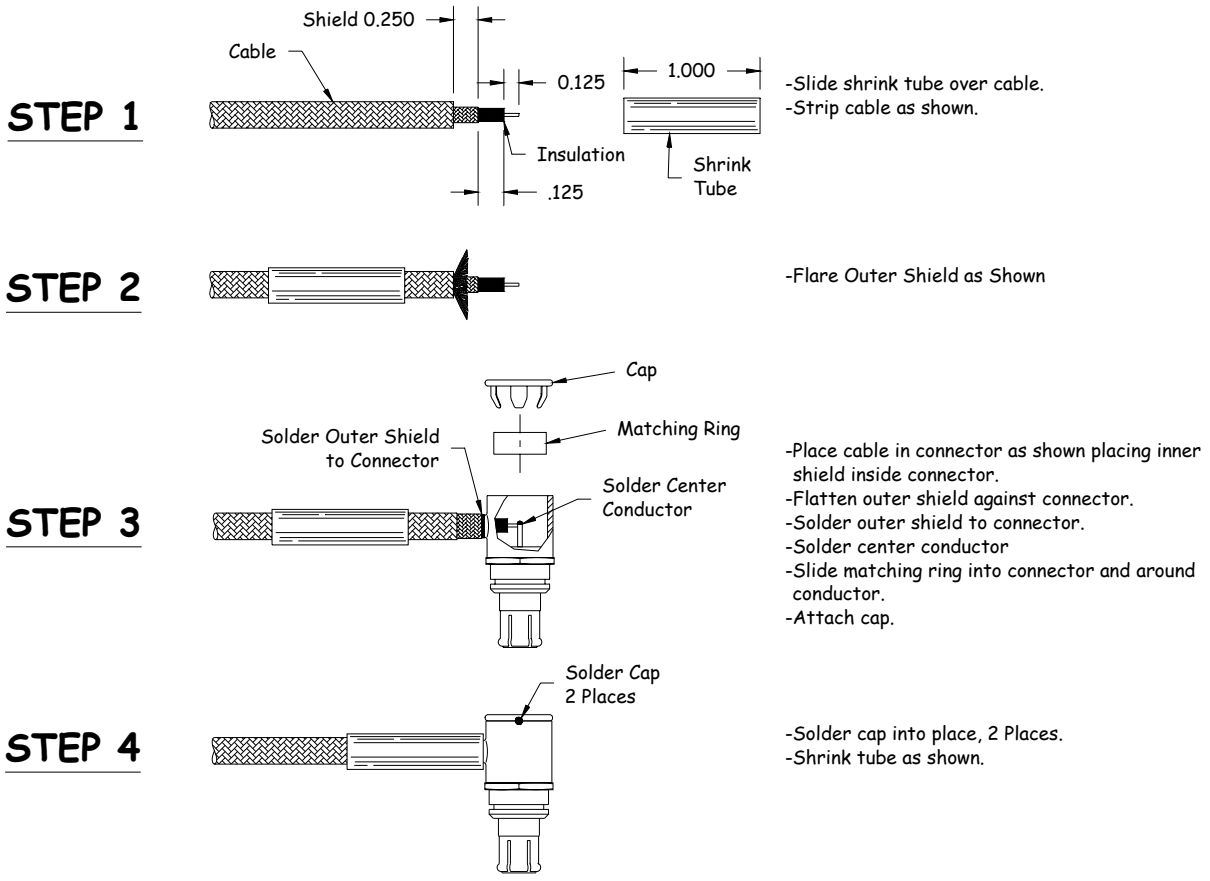
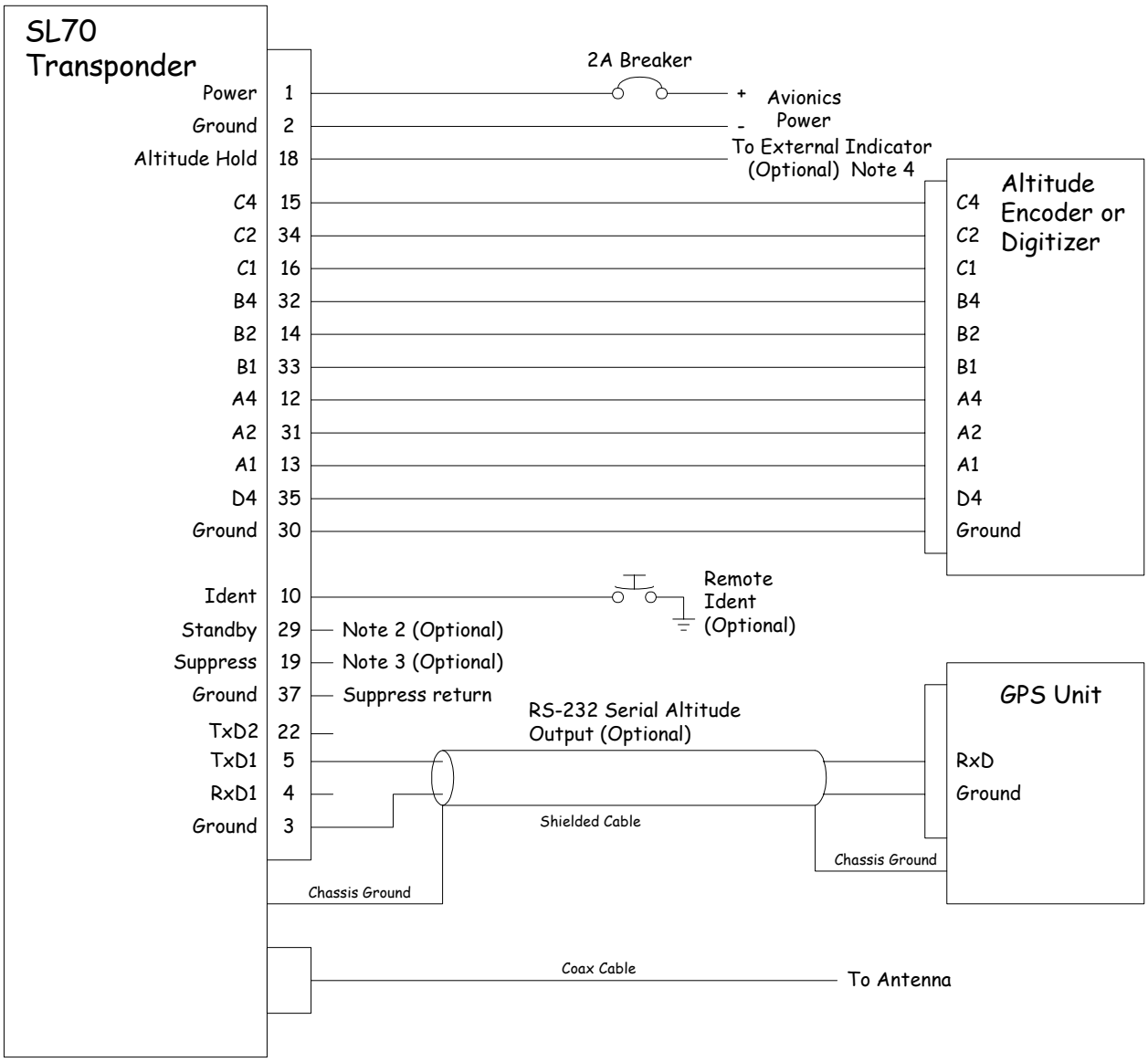


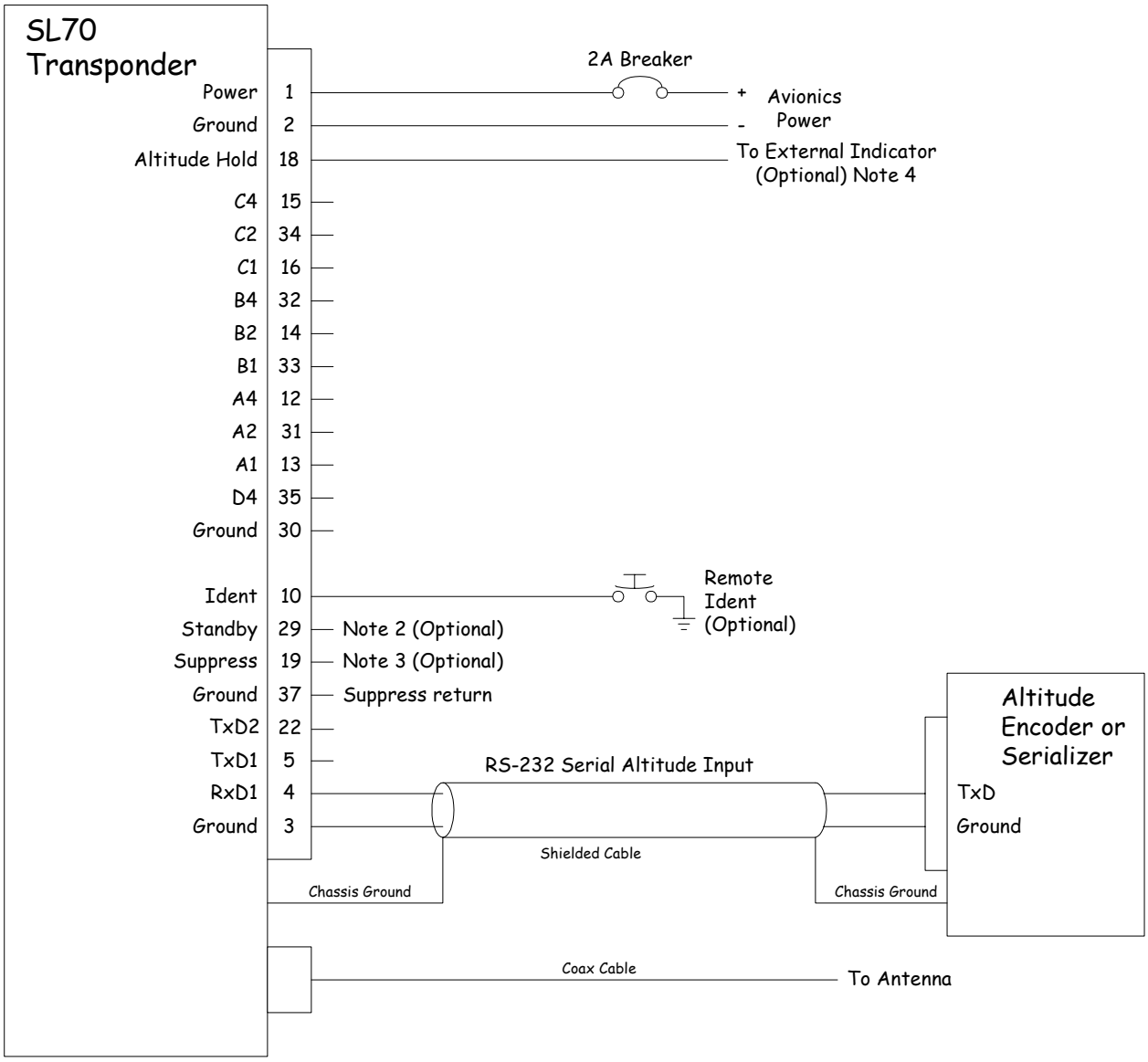
Figure 4 Coax Cable Assembly



Notes:

1. Select the gray code input in the setup mode when using the parallel gray code altitude input.
2. Use standby input to select between two transponders using a selector switch. Unit is in standby when input switched to ground.
3. Suppression input, typically connected to DME suppression output. Transponder is suppressed when input is high.
4. Altitude hold annunciator output is active (grounded) when a preselected hold altitude is exceeded.

Figure 5 Wiring Diagram - Gray Code Altitude Input



Notes:

1. Select altitude input in the setup mode when using RS-232 serial altitude input.
2. Use standby input to select between two transponders using a selector switch. Unit is in standby when input switched to ground.
3. Suppression input, typically connected to DME suppression output. Transponder is suppressed when input is high.
4. Altitude hold annunciator output is active (grounded) when a preselected hold altitude is exceeded.

Figure 6 Wiring Diagram - Serial Altitude Input

POST INSTALLATION CHECKOUT

Once the unit is installed, complete the checkout procedure to verify proper operation. Refer to the user's guide for operating instructions.

The steps that are not applicable to a particular installation may be skipped. Fill out the checkout log sheet during the checkout procedure. The log sheet of page 14 may be photocopied if desired.

Mounting / Wiring Check
Verify that all cables are properly secured and shields are connected to the rear of the mounting frame. Check that cables do not interfere with the movement of the aircraft controls.

TEST MODE CHECKOUT AND SETUP

The SL70 has a built-in setup mode to simplify the checkout. To operate the SL70 in the setup mode, hold down the "IDENT" and "ALT" buttons while switching on the power. To return to normal operation, switch the power off, then back on.

Altitude Input Source Selection
The SL70 altitude input type must be selected. To select the altitude input type:

1. In test mode, rotate the LARGE knob to the "SL70 CONF" (SL70 Configuration) page, then rotate the SMALL knob to the "ASRC" (Altitude source) page.
2. Press IDENT (the altitude type field will start to flash), rotate the SMALL knob to select the altitude type, then press IDENT to save the selection.

The altitude types that can be selected are:

GRAY.....to use the parallel gray code input

SER.....to use the RS-232 serial altitude input

RS-232 Baud Rate Selection
If using the RS-232 serial interface, the baud rate must be selected to match the connected equipment. To select the baud rate:

1. In test mode, rotate the LARGE knob to the "SL70 CONF" (SL70 Configuration) page, then rotate the SMALL knob to the "BAUD" (baud rate) page.
2. Press IDENT (the baud rate field will start to flash), rotate the SMALL knob to select the desired baud rate, then press IDENT to save the selection.

The baud rates available are 1200, 2400, 4800, 9600, and 19200.

VFR Code Selection
The VFR code used by the SL70 when pressing the "VFR" button can be selected as appropriate for the aircraft's operating area. To change the VFR code:

1. In test mode, rotate the LARGE knob to the "SL70 CONF" (SL70 Configuration) page, then rotate the SMALL knob to the "VFR" (VFR code selection) page.
2. Press IDENT (the first VFR code character will start to flash).

3. Rotate the SMALL knob to change the character, rotate the LARGE knob to move the cursor.
4. Press IDENT to save the selection.

OPERATION / PERFORMANCE CHECKOUT

Self Test
The SL70 includes a self test that is executed every time the unit is turned on that checks the receiver and transmitter operation as well as other internal functions.

Verify that the unit does not display a failure indication when turned on.

Altitude Input
Verify that the displayed altitude matches the altimeter pressure altitude (at 29.92).

External Inputs
If the external ident or standby inputs are connected, verify operation by:

a) Verify that the unit goes to standby when the external standby input is pulled low.

b) Verify that the ident LED turns on when the external ident button is pressed (must be in the "ON" or "ALT" modes).

Performance (Ramp) Test
After installation, the transponder should be tested as specified in Appendix F of CFR 14 part 43, to AC 43-6A, and/or other appropriate regulations. The test is typically done as a ramp test using a transponder ramp test set, such as the IFR ATC-600A. The ramp test includes checks as follows.

Reference part 43 Appendix F:

a) reply frequency

b) suppression

c) receiver sensitivity

d) reply RF output power

Reference AC 43-6A:

- altitude reporting

APOLLO SL70 POST-INSTALLATION CHECKOUT LOG Date: ___/___/___
By: _____

CONFIGURATION INFORMATION:

Apollo SL70 430-6090-____ Mod ___
Serial #_____

TEST MODE CHECKOUT AND SETUP:

Self Test:
[ ] Pass
[ ] Fail

Altitude source:
[ ] Gray code (GRAY)
[ ] Serial RS-232 (SER)

RS-232 baud rate: _____
VFR Code: _____

OPERATION / PERFORMANCE CHECK:

Altitude data (on display):
[ ] Pass

Performance verification:
[ ] Pass

External inputs:
[ ] Remote ident checked [ ] N/A
[ ] External standby [ ] N/A

COMMENTS:

INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

Modification of an aircraft for the installation of the SL70 obligates the aircraft operator to include the maintenance information provided by this section in the operator's Aircraft Maintenance Manual and the operator's Aircraft Scheduled Maintenance Program.

1. Maintenance Manual information (system description, operation, location, removal, testing, etc) is contained within this document and any information should be copied to, and /or included with, the operator's airplane Maintenance Manual.
2. Line Replaceable Unit (LRU) part numbers and other necessary part numbers contained in the installation data package should be placed into the aircraft operator's airplane Illustrated Parts Catalog (IPC).
3. The specific wiring diagram information, along with the supplemental information described in the Installation Manual, pertaining to the installation of this unit, should be placed into the aircraft operator's airplane Wiring Diagram Manuals.
4. Scheduled Maintenance Program task to be added to the operator's maintenance program are found in Appendix B - Periodic Maintenance, of this installation manual.

NOTES

SECTION 3 - SPECIFICATIONS

This section includes detailed electrical, physical, environmental, and performance specifications for the Apollo SL70.

ELECTRICAL

Input voltage..... 10VDC to 35VDC, reverse polarity protected

Input current ..... 500mA typical, 1.4A max at 14VDC
270mA typical, 660mA max at 28VDC

Input power ..... 7 watts typical (8 pulse reply, 200 replies / second)
20 watts max (12 pulse reply, 1200 replies / second)
5.8 watts standby

Internal fuse..... 3 amp slow blow (Garmin AT #S172-0007-012)

Memory backup..... Internal EEPROM

PHYSICAL

Height ..... 1.30 inches (3.30 cm)

Width ..... 6.25 inches (15.88 cm)

Depth ..... 11.452 inches (29.09cm) behind panel, including mounting frame and connectors

Weight (with mounting frame)..... 2.64 lb. (1.2 kg)

Required clearance ..... Allow one inch behind unit for connector and cable clearance

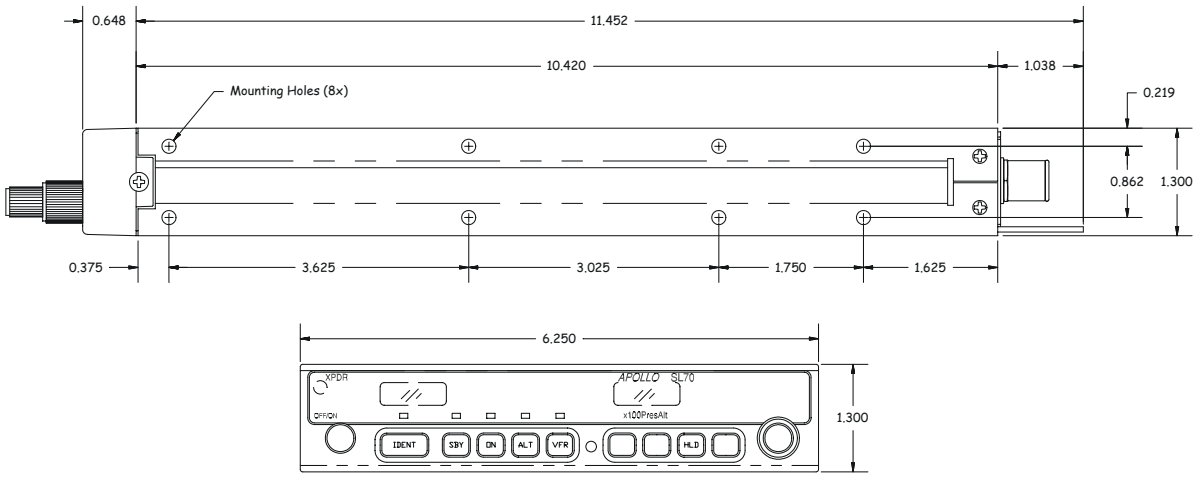


Figure 7 Unit Dimensions

ENVIRONMENTAL

The Apollo SL70 is designed and tested to meet appropriate categories of RTCA/DO-160D. The Environmental Qualification Form is included in Appendix C.

Operating temperature	-20°C to +55°C
Storage temperature	-55°C to +85°C
Temperature variation	2°C per minute
Humidity	95% at 50°C for 6 hours (2 day cycle)
Maximum altitude	25,000 feet
Cooling	Not required

ALTITUDE INPUT

10 bit gray code	Uses 10 bit gray code altitude data, includes isolation diodes. Range: -1000feet to 63,000 feet On: <= 3.5 volts, Off: open
Serial input	Uses RS-232 serial data input (See Appendix E – Serial Interface Specifications)

Note: The altitude data input type must be selected using the setup function during the post installation checkout.

DISCRETE INPUTS

Remote Ident	Input pulled low momentarily to initiate ident transmission (same function as front panel button) On: <= 3.5 volts, Off: open
Standby input	Input pulled low to disable the transponder (will not generate replies) On: <= 3.5 volts, Off: open
Suppression input	Input pulled high to initiate suppression – typically connected to DME suppression output Suppressed: >= 5.0 volts; Not suppressed: < 2.5 volts (or open)

DISCRETE OUTPUTS

Altitude Hold	Capable of sinking 400 mA for turning ON external indicator. Indicates the pilot select hold altitude has been exceeded.

SERIAL INTERFACE

RS-232	Defined in Appendix E – Serial Interface Specifications

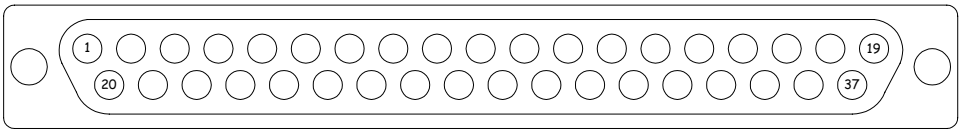
TRANSPONDER PERFORMANCE

TSO	TSO-C74c, Class A2
JTSO	JTSO-C74c, Class 2A
Warm-up	none required
Receiver Frequency	1030 MHz
Sensitivity (MTL)	–72 dBm
Dynamic Range	> 50 dB
Side Lobe Suppression	2 pulse (P1,P2)
Transmitter Frequency	1090 MHz +/- 120 kHz
Transmitter Power	250 watts minimum, 325 watts typical
Reply rate	1200 / second
Mode A Capability	4096 codes plus SPI ident pulse
Mode C Capability	-1000 to 63,000 feet, 100 foot increments, from either gray code or RS-232 serial inputs

ANTENNA REQUIREMENTS

The SL70 requires a standard transponder quarter wave monopole antenna, such as the TED #104-12 or Comant CI-101, and should be approved to TSO-C74c or JTSO-C74c.

Table 2 Rear Connector Pinout			
Pin #	**I/O**	**Connection**	**Function**
1	I	Power +	main DC power input
2	I	Power ground	main DC power ground
3	O	Serial ground	RS-232 serial ground
4	I	RxD1	RS-232 serial data input
5	O	TxD1	RS-232 serial data output
6	O	Reserved	
7	O	Reserved	
8	I	Reserved	
9	I	Reserved	
10	I	Ident	remote ident input (ground momentarily for ident)
11	--	NC	no connection
12	I	A4	A4 altitude gray code input
13	I	A1	A1 altitude gray code input
14	I	B2	B2 altitude gray code input
15	I	C4	C4 altitude gray code input
16	I	C1	C1 altitude gray code input
17	--	Reserved	
18	O		Altitude Hold Annunciator
19	I	Suppress	remote suppression input (high for suppression)
20	O	NC	no connection
21	I	Reserved	
22	O	TXD2	RS-232 Serial Data Output – Duplicates TxD1 Data
23	--	NC	no connection
24	--	Ground	
25	I	Reserved	
26	I	Reserved	
27	--	Ground	
28	--	Ground	
29	I	Standby	remote standby input (ground for standby)
30	--	Ground	
31	I	A2	A2 altitude gray code input
32	I	B4	B4 altitude gray code input
33	I	B1	B1 altitude gray code input
34	I	C2	C2 altitude gray code input
35	I	D4	D4 altitude gray code input
36	--	Reserved	
37	--	Ground	



Viewed from rear of unit

Note: Buffered serial data is output on pins 5 And 22 (TxD1 and TxD2). The same data is output on both pins.

Note: Second serial output (pin 22) and Altitude Hold Annunciator not available prior to 430-6090-1xx Mod G.

SECTION 4 - LIMITATIONS

INSTALLATION

Aircraft installation must be made in accordance with this installation manual and applicable FAA regulations and advisory circulars.

OPERATIONAL

The SL70 must be operated within the limitations as follows, or by other regulatory guidance as appropriate.

1. The altitude reply data may be verified by comparing the pressure altitude display to the aircraft altimeter relative to a barometric setting of 29.92.
2. The transponder is to be operated in compliance with CFR 14 section 91.215 for ATC transponder and altitude reporting equipment.
3. The transponder must be tested as specified in CFR 14 section 91.413 within the previous 24 months.

NOTES

APPENDIX A - TROUBLESHOOTING

This appendix provides information to assist troubleshooting if problems occur after completing the installation. Use Table 3 to assist in troubleshooting.

Table 3. Troubleshooting Guide

Problem	Cause	Solution
The SL70 does not power on.	The unit is not getting power.	Check power connections, breakers, and main avionics switch.
The altitude is not correct.	The unit is not getting the correct altitude.	If the gray code inputs are used, check all connections from the altitude source and/or verify the altitude source.
		If the serial altitude input is used, check for the correct baud rate and connections to the altitude source.
The altitude display is "---"	The unit is not getting an altitude, or the altitude is invalid.	Check the connections to the altitude source. Check the altitude source to make sure it is operating correctly.
The unit fails the start-up self-test.	TX fails.	Check antenna connections. May have an open, a short, or a bad VSWR.
	Other failure.	The unit may need repair. Contact the factory for assistance.
The unit does not generate replies.	The unit is in standby.	The unit must be in either the "On" or "Alt" modes to generate replies.
	The unit is not receiving interrogation signals.	Check the antenna connections. If the unit does not "Fail" the receive test, then check antenna connections.
	No interrogation signal available.	Need to either use a ramp test set or climb to altitude where ATC radar service is available.

If the SL70 displays a "Test Fail" message when turned on, the test status and source of the failure can be displayed by rotating the SMALL knob. If the source is either a transmit or receive failure, the unit will not operate. If the source is any other item, the unit should continue to operate (press any of the mode buttons), but should be repaired.

CONTACTING THE FACTORY FOR ASSISTANCE

If the Apollo SL70 unit fails to operate despite troubleshooting efforts, contact the Garmin AT factory for assistance.

Garmin AT, Inc.
2345 Turner Rd. S.E.
Salem, Oregon 97302
U.S.A.

Phone (503)581-8101 or 1-800-525-6726

Be prepared to offer the following information about the installation:

- Installation configuration (accessories, antenna, ...)
- Model number, part number with mod levels, and serial number
- Software versions (The software versions can be displayed in the setup mode by rotating the LARGE knob to the "SW VER" page, and rotating the SMALL knob to display the microcontroller and FPGA versions.)
- Description of problem
- Efforts made to isolate the problem

APPENDIX B - PERIODIC MAINTENANCE

The Apollo SL70 is designed to not require any regular general maintenance except as included in this section.

BIENNIAL CHECK

The transponder must be tested within the previous 24 months as specified in 91.413 of the FAA regulations.

No other periodic maintenance is required.

CLEANING THE FRONT PANEL

The front bezel, keypad, and display can be cleaned with a soft cotton cloth dampened with clean water. DO NOT use any chemical cleaning agents. Extreme care must be taken to avoid scratching the surface of the display.

NOTES

APPENDIX C - ENVIRONMENTAL QUALIFICATIONS

The Apollo SL70 has been tested to the following environmental categories per procedures defined in RTCA/DO-160D.

Environmental Qualification Form		
Nomenclature: Apollo SL70 Part No.: 430-6090-xxx TSO No.: TSO-C74c		Manufacturer: Garmin AT, Inc. 2345 Turner Road SE Salem, Oregon 97302
Conditions	**Section**	**Description of Conducted Tests**
Temperature and Altitude In-flight Loss of Cooling Altitude Decompression Overpressure	4.0 4.5.4 4.6.1 4.6.2 4.6.3	Equipment tested to Category B1 with ..... No cooling required Equipment tested to 25,000 feet Equipment tested for decompression to 25,000 feet Equipment tested for overpressure
Temperature Variation	5.0	Equipment tested to Category C, 2°C/min
Humidity	6.0	Equipment tested to Category A, standard humidity environment
Operational Shocks and Crash Safety	7	Equipment tested for both operational and crash safety shocks. (Equipment operates normally after both the crash safety shocks.)
Vibration	8.0	Equipment tested without shock mounts to Categories S(B,M)
Explosion Proofness	9.0	Equipment identified as Category X, no test required
Waterproofness	10.0	Equipment identified as Category X, no test required
Fluids Susceptibility	11.0	Equipment identified as Category X, no test required
Sand and Dust	12.0	Equipment identified as Category X, no test required
Fungus Resistance	13.0	Equipment identified as Category X, no test required
Salt Spray	14.0	Equipment identified as Category X, no test required
Magnetic Effect	15.0	Equipment is Class Z
Power Input	16.0	Equipment tested to Categories A (28volt systems) & B (14 and 28 volt systems)
Voltage Spike	17.0	Equipment tested to Category A
Audio Frequency Conducted Susceptibility – Power Inputs	18.0	Equipment tested to Categories A & B
Induced Signal Susceptibility	19.0	Equipment tested to Category Z
Radio Frequency Susceptibility (Radiated and Conducted)	20	Equipment tested to Category V
Emission of Radio Frequency Energy	21	Equipment tested to Category M*
Lightning Induced Transient Susceptibility	22.0	Equipment tested to A3 and B2
Lightning Direct Effects	23.0	Equipment identified as Category X, no test required
Icing	24.0	Equipment identified as Category X, no test required
Electrostatic Discharge (ESD)	25.0	Equipment tested to Category A
Remarks: *TSO requirements do not require emission testing above 1.2GHz. Intentional radiators at the second harmonic, 2.18GHz and at the fourth harmonic, 4.36GHz, may be above the limits as specified by DO-160D. The SL70R meets all of the environmental qualification requirements of TSO-C74c, it was qualified to and met the higher DO-160D standard with the exception as indicated above.		

NOTES

APPENDIX D – ACCESSORIES

This appendix includes information on accessory items available for the Apollo SL70. Refer to the information that is provided with those items for complete specifications and installation instructions.

FROM GARMIN AT

INTERNAL FUSE

Garmin AT, Inc. Part #: S172-0007-012

Description.....3 amp slow blow fuse

NOTES

APPENDIX E - SERIAL INTERFACE SPECIFICATION

HOST INTERFACE

The SL70 communicates with a "host" unit such as a navigation computer or a test setup. Any device connected to the SL70's external serial port will be referred to as the "host."

BAUD RATE

The SL70 has a configurable baud rate from 1200 to 19200. Both the input and output are set to the specified baud rate. A typical serial altitude encoder provides serial altitude data at 1200 baud. When connecting to a host expecting standard serial altitude date (i.e. NMC, GX50/60, …) the baud rate must be set to 1200.

COMMUNICATIONS

Establishing communications between the SL70 and the host is independent of which device is turned on first. The SL70 operates in a broadcast mode. Once the startup is finished, the SL70 will begin sending the appropriate serial data and processing any incoming serial data.

MESSAGE DEFINITIONS

Messages are divided into two groups. The standard message group, which contains the #AL and ^SS messages, is the most compatible with altitude encoder inputs found on products such as the GX50/60/55. The extended message group adds ^MD, ^AH and ^RC messages. The ^C1 message is sent upon request. The selection for standard or extended is configured during the installation setup and saved in the EEPROM.

OUTPUT MESSAGES

Table 4. Output Messages

Msg ID	Description	Notes
	STANDARD	
#AL	Altitude Message	1 second interval approximate
^SS	System Status	On power up & continuously upon failure
	EXTENDED	
^MD	Operation Mode Message	1 second interval approximate
^AH	Alt Hold Message	1 second interval approximate
^RC	Replies per second	1 second interval approximate
^C1	Configuration 1 - Software Versions	Upon request

ALTITUDE

The altitude output function is intended to interface with other Apollo products that have serial altitude input. This message is output in both normal and test modes.

Interface Specification

Baud Rate:	See Baud Rate, Page 23
Data Bit:	8 bits
Stop Bit:	1 bit
Parity:	None
Output Rate:	Approx. 1 sec.
Buffer Length	17 bytes

Altitude Format Specification

Table 5. Altitude Message Format

Byte	Contents	Description
0	'#'	ASCII '#' (0x23)
1	'A'	ASCII 'A' (0x41)
2	'L'	ASCII 'L' (0x4C)
3	' '	ASCII space (0x20)
4	'+' or '-'	Altitude sign; ASCII '+' or '-' (0x2B or 0x2D)
5-9	ddddd	Altitude in feet (100 ft resolution)
10-13	'T+15'	Temperature (always +15)
14-15	dd	Checksum of bytes 0 through 13. In hex ASCII i.e. "FA"
16	'\r'	ASCII carriage return (0x0D)

Altitude Format Specification Examples

#AL +00100T+15D1	100 feet above sea level (@29.92 inches Hg) with temperature @+15°C
#AL -09981T+15ED	ERROR CODE invalid data @+15°C

Altitude Error Codes

The altitude encoder/converter may place an error code in bytes 4-9. Here is a list of the possible codes:

- -09981=Possible Hardware Problem

The converter issues this code if the temperature of the internal heater is greater then 55°C, indicating a possible hardware problem or the data received from the encoder is invalid indicating a possible encoder or wiring problem.

- -09982=Altitude Out of Range

Both the encoder and converter will send this code when the altitude is outside the specified limits for the device.

MODE MESSAGE

The mode message indicates the current operating mode. It includes the following: 1) current mode, Standby, Mode A or Mode C, 2) Ident enabled/disabled, 3) current Squawk code setting and 4) heart beat received. This message is output in both normal and test modes.

Interface Specification

Baud Rate:	See Baud Rate, Page 23
Data Bit:	8 bits
Stop Bit:	1 bit
Parity:	None
Output Rate:	Approx. 1 sec. when EXT (extended) messages are selected.
Buffer Length	17 bytes

Mode Format Specification

Table 6. Mode Message Format

Byte	Contents	Description
0	'^'	ASCII '^' (0x5E)
1	'M'	ASCII 'M' (0x4D)
2	'D'	ASCII 'D' (0x44)
3	' '	ASCII space (0x20)
4	m	See Mode Table below
5	','	ASCII comma (0x2C)
6	i	See Ident Table Below
7	','	ASCII comma (0x2C)
8-11	dddd	ASCII Squawk code
12-13	hh	LSB = 1 heart beat received In hex ASCII "01"
14-15	dd	Checksum of bytes 0 through 13. In hex ASCII i.e. "FA"
16	'\r'	ASCII carriage return (0x0D)

Table 7. Mode Table

m	Definition	ASCII
O	Standby Mode	0x4F
A	Mode A	0x41
C	Mode C	0x43

Table 8. Ident Table

i	Definition	ASCII
I	Ident Enabled	0x49
-	Ident is Inactive	0x2D

Mode Message Examples

^MD O,-,12000006	Standby Mode, Ident inactive, Squawk code is 1200
^MD A,I,23540120	Mode A, Ident active, Squawk code is 2354

ALTITUDE HOLD

The altitude hold message includes 1) hold altitude, 2) altitude limit, 3) indication if within the limit, 4) altitude hold active or inactive. This message is output in both normal and test modes.

Interface Specification

Baud Rate: See Baud Rate, Page 23

Data Bit: 8 bits

Stop Bit: 1 bit

Parity: None

Output Rate: Approx. 1 sec. when EXT (extended) messages are selected.

Buffer Length 17 bytes

Alt Hold Format Specification

Table 9. Mode Message Format

Byte	Contents	Description
0	'^'	ASCII '^' (0x5E)
1	'A'	ASCII 'A' (0x41)
2	'H'	ASCII 'H' (0x48)
3	' '	ASCII space (0x20)
4	s	See Table 10. Alt Hold State Table
5	'+' or '-'	Altitude sign; ASCII '+' or '-' (0x2B or 0x2D)
6-10	ddddd	Altitude in feet (right justified with zeros)
11	','	ASCII comma (0x2C)
12-13	dd	Altitude Limit in 100's feet 2(00) -> 25(00)
14-15	dd	Checksum of bytes 0 through 13. In hex ASCII i.e. "FA"
16	'\r'	ASCII carriage return (0x0D)

Table 10. Alt Hold State Table

m	Definition
'O'	(0x 4F) Outside of Limit
'I'	(0x49) Inside or at Limit
'-'	(0x2D) Hold Inactive or Altitude not valid

Alt Hold Example

^AH I+00600,0300 hold alt is 600 ft, limit is ±300 ft and currently inside of limit

^AH O+60900,030F hold alt is 60,900ft, limit is ±300 ft and currently outside of limit

REPLY COUNT

The reply count message indicates the number of replies per second that are being sent.

Interface Specification

Baud Rate: See Baud Rate, Page 23
Data Bit: 8 bits
Stop Bit: 1 bit
Parity: None
Output Rate: Approx. 1 sec. when EXT (extended) messages are selected.
Buffer Length 11 bytes

Reply Count Format Specification

Table 11. Reply Count Message Format

Byte	Contents	Description
0	'^'	ASCII '^' (0x5E)
1	'R'	ASCII 'R' (0x52)
2	'C'	ASCII 'C' (0x43)
3	' '	ASCII space (0x20)
4-7	dddd	ASCII Digit (ex. 1234)
8-9	dd	Checksum of bytes 0 through 7. In hex ASCII i.e. "FA"
10	'\r'	ASCII carriage return (0x0D)

Reply Count Format Specification Examples

^RC 1200D6 1200 replies per second

CONFIGURATION MESSAGE

This message provides a way to send configuration information.

C1 – contains the software version numbers for the microcontroller and FPGA

Interface Specification

Baud Rate: See Baud Rate, Page 23

Data Bit: 8 bits

Stop Bit: 1 bit

Parity: None

Output Rate: Upon Request.

Buffer Length 16 bytes

Software Version Format Specification

Table 12. Configuration 1 Message Format

Byte	Contents	Description
0	'^'	ASCII '^' (0x5E)
1	'C'	ASCII 'C' (0x43)
2	'1'	ASCII '1' (0x31)
3	' '	ASCII spaces (0x20)
4-5	dd	Micro SW major revision number
6	d	Micro SW minor revision number
7	','	ASCII comma (0x2C)
8	d	FPGA major revision number
9	d	FPGA minor revision number
10	c	Transponder Configuration C= Mode A/C S= Mode S
11-12	xx	Reserved for future use fill with spaces (0x20)
13-14	dd	Checksum of bytes 0 through 8. In hex ASCII i.e. "FA"
15	'\r'	ASCII carriage return (0x0D)

Configuration 1 Example

^C1 010,10C 93 Micro SW Version 010, FPGA SW version 1.0 Mode A/C Transponder

SYSTEM STATUS

The system status message contains the 14 bits of status information as defined below in Table 13. When a bit is set the particular item is functioning properly.

Table 13. Self-Test Bit Definition

Bit #	Definition
0	3.3 Volt Power Supply
1	5 Volt Power Supply
2	8 Volt Power Supply
3	12 Volt Power Supply
4	45 Volt Power Supply
5	High Voltage Power Supply
6	Input Voltage
7	Discrete Input Reference V
8	Display Temperature
9	Transmitter Temperature
10	Photo Cell
11	Synthesizer Locked
12	Receiver Test
13	Transmitter test
14	Suppression Stuck
15	Unused

Interface Specification

Baud Rate: See Baud Rate, Page 23

Data Bit: 8 bits

Stop Bit: 1 bit

Parity: None

Output Rate: At Start up and continuously upon fail condition at 1 second intervals.

Buffer Length 11 bytes

System Status Format Specification

Table 14. Software Version Message Format

Byte	Contents	Description
0	'^'	ASCII '^' (0x5E)
1	'S'	ASCII 'S' (0x53)
2	'S'	ASCII 'S' (0x53)
3	' '	ASCII spaces (0x20
4-7	dddd	Status Data Hex ASCII
8-9	dd	Checksum of bytes 0 through 8. In Hex ASCII i.e. "FA"
10	'\r'	ASCII carriage return (0x0D)

System Status Message Example

^SS FFFF3C no failures

^SS FFFE3B 3.3 volt supply failure.

INPUT MESSAGES

The following messages are processed during normal operation. These messages will take precedence over front panel selections. The AL and SW messages are also processed during setup and test modes.

Table 15. Input Messages

Msg ID	Description	Notes
#AL	Altitude Message	Must be selected in set up mode or it will be ignored.
#MD	Set Mode Message	Set mode A/C or STBY, IDENT and squawk code
#SW	Request Software Version	SL70 replies with Software Version Message
#RS	Reset	SL70 will reset after approximately 1 second.

ALTITUDE

The altitude-input function is intended to interface with serial altitude encoders. The altitude source is selected during installation and must be set to Serial for this message to be processed. Once selected the SL70 must receive a valid message at least once every 2 seconds or the altitude will time out and become invalid until the next valid message is received.

Interface Specification

Baud Rate: See Baud Rate, Page 23

Data Bit: 8 bits

Stop Bit: 1 bit

Parity: None

Buffer Length 17 bytes

Altitude Format Specification

Table 16. Altitude Message Format

Byte	Contents	Description
0	'#'	ASCII '#' (0x23)
1	'A'	ASCII 'A' (0x41)
2	'L'	ASCII 'L' (0x4C)
3	' '	ASCII space (0x20)
4	'+' or '-'	Altitude sign; ASCII '+' or '-' (0x2B or 0x2D)
5-9	ddddd	Altitude in feet (right justified with zeros)
10	'T'	ASCII 'T' (0x54)
11	'+' or '-'	Temperature sign; ASCII '+' or '-' (0x2B or 0x2D)
12-13	dd	Internal Altimeter Temperature
14-15	dd	Checksum of bytes 0 through 13. In hex ASCII i.e. "FA"
16	'\r'	ASCII carriage return (0x0D)

Altitude Format Specification Examples

#AL +02100T+25D4 @+25°C	2100 feet above sea level (@29.92 inches Hg) with temperature
#AL -00045T+45DE @+45°C	45 feet below sea level (@29.29 inches Hg) with temperature
#AL -09980T-12E6	ERROR CODE (temp below +25°C) with temperature @-12°C

Altitude Error Codes

The altitude encoder/converter may place an error code in bytes 4-9. Here is a list of the possible codes:

- -09980=Heater Not Ready

The encoder issues this code while the unit is in the warm-up phase.

- -09981=Possible Hardware Problem

The converter issues this code if the temperature of the internal heater is greater then 55°C, indicating a possible hardware problem or the data received from the encoder is invalid indicating a possible encoder or wiring problem.

- -09982=Altitude Out of Range

Both the encoder and converter will send this code when the altitude is outside the specified limits for the device.

MODE

The mode message sets the unit's current operating mode. This includes: 1) selecting Standby, Mode A or Mode C, 2) enabling Ident 3) adjusting squawk code. This message is not processed when in setup or test modes. It will also not be process if a system failure has occurred.

Interface Specification

Baud Rate:	See Baud Rate, Page 23
Data Bit:	8 bits
Stop Bit:	1 bit
Parity:	None
Buffer Length	15 bytes

Mode Format Specification

Table 17. Mode Message Format

Byte	Contents	Description
0	'#'	ASCII '#' (0x23)
1	'M'	ASCII 'M' (0x4D)
2	'D'	ASCII 'D' (0x44)
3	' '	ASCII space (0x20)
4	m	See Mode Table below
5	','	ASCII comma (0x2C)
6	i	See Ident Table Below
7	','	ASCII comma (0x2C)
8-11	Dddd	ASCII Squawk code
12-13	Dd	Checksum of bytes 0 through 11. In hex ASCII i.e. "FA"
14	'\r'	ASCII carriage return (0x0D)

Table 18. Mode Table

m	Definition	ASCII
O	Standby Mode	0x4F
A	Mode A	0x41
C	Mode C	0x43

Table 19. Ident Table

i	Definition	ASCII
I	Ident Enabled	0x49
-	Ident is disabled	0x2d

Mode Message Examples

#MD O,-,12006B Standby Mode, Ident inactive, Squawk code is 1200

#MD A,I,235484 Mode A, Ident active, Squawk code is 2354

SOFTWARE VERSION

The software version message requests the software version be sent. In response the SL70 will send the configuration message which includes the software versions.

Interface Specification

Baud Rate: See Baud Rate, Page 23

Data Bit: 8 bits

Stop Bit: 1 bit

Parity: None

Buffer Length 6 bytes

Software Version Message Specification

Table 20. Software Version Message Format

Byte	Contents	Description
0	'#'	ASCII '#' (0x23)
1	'S'	ASCII 'S' (0x53)
2	'W'	ASCII 'W' (0x57)
3-4	'CD'	Checksum = CDH
5	'\r'	ASCII carriage return (0x0D)

RESET

The reset message will cause the SL70 to reset. It will take approximately 1 second for the unit to reset after receiving the message.

Interface Specification

Baud Rate: See Baud Rate, Page 23

Data Bit: 8 bits

Stop Bit: 1 bit

Parity: None

Buffer Length 6 bytes

Reset Message Specification

Table 21. Reset Message Format

Byte	Contents	Description
0	'#'	ASCII '#' (0x23)
1	'R'	ASCII 'R' (0x52)
2	'S'	ASCII 'S' (0x53)
3-4	'C8'	Checksum = C8H
5	'\r'	ASCII carriage return (0x0D)

NOTES

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GARMIN